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Abstract

FAST CRITICAL EXPERIMENTS AND THEIR ANALYSIS

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Fast-reactor critical experiments in the United States since 1958 have been conducted by three principal organizations, the Argonne National Laboratory, the Los Alamos Scientific Laboratory and Atomics International. The experimental results obtained and their analysis, although strongly overlapping, are primarily concerned with systems of different types. A brief description of each facility will be given and the experimental results and analysis discussed.

Argonne National Laboratory's Zero Power Reactor No. III (ZPR-III) located at the National Reactor Testing Station in Idaho has conducted studies on 23 different assemblies in addition to those reported at the Second Geneva Conference. In contrast to those previously presented, which were, in the main studies of metal-fueled systems including a few with graphite added for spectrum softening, this report will present results on metal, oxide, carbide, and cermet fueled reactor assemblies ranging in size up to 665 liters, and with critical masses up to 580 kg of uranium-235. Included in these are two studies on possible meltdown configurations. Also included are studies of two zoned loadings, (1) where the central zone simulates the composition and neutron spectrum of a previously built reactor, to permit comparisons of zoned vs. full critical techniques, and (2) where the central zone simulates the composition and spectrum of a 5000-liter uranium carbide fueled core. On this latter core, measurements of the sodium reactivity coefficient and the Doppler effect for uranium-238 will be reported. Other measurements to be reported

include critical mass, reactivity effects of various materials, spectrum determinations using fission ratios of U-235, U-238, U-234, U-236, Pu-239, Pu-240, and Rossi-α.

Two plutonium-fueled assemblies have been constructed and will also be discussed. One was a subcritical assembly, built to study the effects of self-heating and spontaneous fission in plutonium. The second was a mock-up of the French Rapsodie reactor.

Extensive analysis of these systems indicates agreement between the calculated and experimental critical size for a wide range of compositions using a modified Yiftah, Okrent, Moldauer cross-section set. Calculation of danger coefficients, fission ratios and neutron lifetime exhibit discrepancies. These results will be discussed.

Argonne's Zero Power Reactor No. VI (ZPR-VI) located at Argonne, Illinois, first started operation in July, 1963. Two U-235 fueled assemblies have been constructed. The first was a repeat of ZPR-III Assembly 22. The second was a 650-liter uranium carbide fueled reactor simulation. Emphasis has been placed on measurements of the reactivity coefficient of sodium density. These results will be discussed.

Atomics International's Advanced Epithermal Thorium Reactor (AETR) critical facility has been used to study 10 assemblies in zoned core loadings. Test zone sections with U-233 and U-235 fuel have been constructed with median fission energies varying from 422 keV to 0.0085 keV. In addition to fission ratio and danger-coefficient determinations, a measure of neutron importance as a function of energy was obtained by measuring the reactivity effect of introducing a series of carefully calibrated sources emitting neutrons of different energies. The Doppler effect for Th-232, U-235, and U-238 has been measured in an assembly with a median fission energy of about 190 keV. The results of the experiments and a comparison with calculation will be given.

At the Los Alamos Scientific Laboratory fast reactor studies have included experiments with the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE). Determinations of the critical mass as a function of temperature and control reflector position have been made. Experimental results and their analysis will be reported.